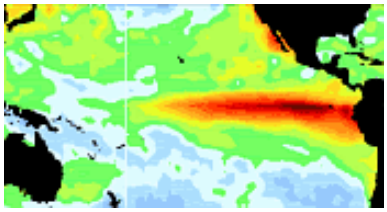
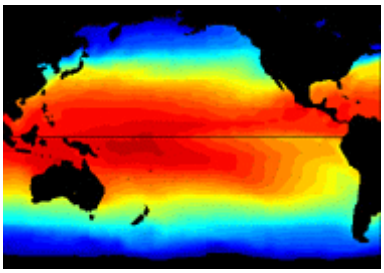
Climate Research Theme

Understanding complex climate systems to improve predictions





Overview

The march of the seasons imparts a rhythm to life on Earth. Over much of the world, climate swings like a pendulum between summer and winter. Even in the tropics, where the weather is warm year-round, rainy seasons alternate with dry seasons and each has its own distinct pattern of prevailing winds.

Humans have learned to adapt to the changing seasons. Throughout history, people have sown and harvested crops, bred livestock, deployed fishing vessels, and planned hunting expeditions according to a well-defined series of calendar dates. Centuries of tradition have influenced the way we schedule events and activities such as construction projects, military campaigns, school vacations, on- and off-season rates in hotels, and even the sales of umbrellas and swimwear.

But the rhythm of the seasons cannot always be relied upon. Natural cycles and events may result in climatic fluctuations. During an El Niño event, the tropical Pacific Ocean and large expanses of the global atmosphere seem to be marching to the beat of a different drummer, disrupting the normal patterns of life of countless species of plants and animals along with hundreds of millions of human beings. Over longer time spans, natural changes in the energy received from the sun and the amounts of greenhouse gases and dust in the atmosphere have caused the climate to swing in and out of ice ages.

In addition, the balance of evidence suggests a discernible human influence on the global climate system. The amounts of many greenhouse gases in the atmosphere are increasing, especially that of carbon dioxide. Carbon dioxide has increased by 30% over the last 200 years, primarily as a result of changes in land use and of burning coal, oil, and natural gas. In addition, the chlorine and bromine in human-produced chemicals such as chlorofluorocarbons (CFCs) and halons are depleting ozone in the stratosphere, where it acts as a shield by absorbing biologically active ultraviolet light (UV-B) from the sun. As the ozone layer is depleted, more of this UV-B radiation reaches the surface of the earth with potentially harmful consequences.

Climate observations, targeted research, and improvements in computing technology have provided a capability today to predict variations in some climate signals and to predict longer-term climate change with some degree of confidence. Climate researchers are now able to simulate the main features of the current climate, including the seasonal cycle of temperature, the seasonal shift of the major rain belts and storm tracks, and average daily temperature cycles. However, major gaps in understanding remain. NOAA is working to anticipate the occasional lapses in the march of the seasons and help societies plan accordingly.

Key Issues for the United States

The sharp rise in demand for climate information as input to decision-making drives the NOAA research agenda to improve knowledge of the mechanisms that control our climate. For example, producing drought warnings 3-6 months in advance will mitigate agricultural and economic impacts, as well as allow for better water resource management. The possibilities for using climate forecasts are nearly endless, but extensive research is still needed to fully realize them.

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NOAA Research addresses these key issues by conducting the following research:

Impacts on Public Safety

Tremendous potential exists for enhanced prediction of our variable and changing climate. Such improvement can save millions of lives and billions of dollars as we endure flooding, heat stress, drought, significant changes in sea level, and potentially increased hurricane intensity. NOAA researchers are working to better characterize the natural and human influences on climate, and assess risks on regional and global scales to help society cope with potential impacts.

Impacts on the Economy

Climatic events have a variety of impacts across regions, sectors, and individuals. Climate variations can affect crops, oil prices, reservoir levels, construction and seasons, tourism, insurance costs, snow removal costs, etc. NOAA researchers are creating innovative tools, technologies, and applications for societal and economic gain by providing the knowledge base necessary to convert potential threats into opportunities.

Impacts on Public Health

Climate change and variability can also significantly affect human health. For example, during the 1997-98 El Niño, increased rainfall in the U.S. Southwest fostered vegetation growth which increased allergies and raised concerns about the threat of a hantavirus outbreak. NOAA Research aims to improve our ability to forecast the climatic conditions under which these threats to human health thrive.

Impacts on National Security

Increasing environmental threats, such as climate change, can be a factor in security crises in many places around the world. Rising numbers of displaced persons and immigration aggravate already strained environmental and political systems. NOAA is building an improved capability to forecast climate, which would vastly strengthen governments' abilities to mitigate events that currently cause these short-term security problems.

What NOAA Research Can Do

- Provide the *in situ* observation and monitoring program (oceans and atmosphere) to ensure a long-term, high-quality record of the climate system, its variability, and changes that are occurring;
- Conduct field and laboratory experiments to understand and characterize the natural and human-induced chemical changes occurring in the global atmosphere, especially as they relate to climate and the ozone layer;
- Better characterize and understand the role of the oceans in weather and climate predictions;
- Obtain the understanding and skills needed to forecast short-term climate fluctuations;
- Develop the climate system models necessary to understand climate change, reproduce the natural variability of the Earth's climate, and project future climate change;
- Provide science-based information regarding climate variations to policy-makers;
- Meet increasing national demands for integrated climate information products and services by converting advances in research to practical application; and
- Understand and characterize the recovery of the ozone layer, which is expected to occur over the coming decades.